Known Issues in the MODIS Version-5 Land Cover Product [January 29, 2010]

This file documents known problems in the V5 land-cover product and any attempts to correct these errors. The problems will be described in order of generality from highly specific to more general issues.

- The center of some of the largest glaciers in southern Chile, within the Aisen and Magallanas regions, contained rectangular strips of misclassified data because of problems with cloud screening of input NBAR data. Much of this problem was resolved and it was correctly classified as snow/ice; however, there remains a band of misclassified open shrubland around the artifact. In addition, in some years, parts of this region were misclassified as grassland, forest, or shrubland because of noisy input data.

- Iceland has a large area of barren high altitude rock around the glaciers in the center of the island, which is consistently classified as water. Because of this, a number of artificial lakes appear on the edges of the major glacier of Iceland, and this problem may be identified on the barren edges of other high latitude glaciers. Several attempts were made to resolve this fix and the remaining misclassified lakes are much smaller than that of the initial results or of the V4 product.

- Large salt flats such as the Salar de Uyuni in Bolivia are being classified as snow due to their extremely bright surface, a seasonal presence of water, and a high elevation. The Great Salt Lake in Utah also has this problem along its edges.

- Much of the forest along the western side of the south island of New Zealand could be mixed with conifer species such as rimu (*Dacrydium cupressinum*) or *Podocarpus sp.* but largely remain classified evergreen broadleaf forests.

- There is a significant offset to the intersection of the tiles h16v00 and h16v01. This is inherited from the V4 product and possibly even as early V3, as we aren't able to classify tile h16v00 because of missing data. The tile h16v00 is entirely unreliable.

- We may be overestimating permanent snow/ice around high arctic islands in areas that are obviously sea-ice or contain some lowland snow cover that melts during several months of the year.

- The urban mask has been upgraded from the previous version and greatly improved upon but it still may be underestimating urban areas that are in tropical regions because of a higher level of evergreen plant cover.
- One of the largest remaining known issues is that of a coastal band of evergreen needleleaf forest in many temperate to boreal regions (this issue has been largely resolved in tropical regions by relabeling these pixels to wetland). This problem results from the misclassification of mixed water/vegetation pixels, which contain a strong vegetation signal but appear dark similar to a conifer forest due to their water content.
- Significant problems have been detected in the training data, which may have serious consequences for the classified data. These regions include the Patagonia Steppe region of South America misclassifying grassland as open shrubland, the savannas of South Africa misclassifying open shrubland as savanna, and the high tundra of northern Russia misclassifying grassland as open shrubland. Overall, we are still overestimating forest cover in most areas and under-classifying woody savanna due to deficiencies within the training data.
- In some high latitude regions there appears to be an impossible transition from woodland to closed shrubland.
- The area covered by open shrublands are vastly overestimated and many of these regions such as in high tundra zones or steppes could be better characterized as grassland while others in arid zones actually have less than 10% shrub cover and should be classified as barren or sparsely vegetated.
- Other problematic classes include savanna, mixed forests, wetlands, and agriculture/natural mosaic.
    - A lot of the area classified as savanna in southern Africa and in Brazil could be shrubland, grassland, or agriculture.
    - The depiction of wetlands in global land cover classifications needs an independent classification similar with how a separate map is produced for urban areas. This is because of the mixtures of water with different vegetation types and the global diversity of flooding regimes. For now we

use thresholds to both reduce and augment wetlands, which results in a low user's confidence for the wetland class as a whole.

- o The width of the temperate mixed forest zone, which represents a transition from temperate to boreal zones around the world, may be overestimated. A mixture label may be more popular because of its characteristics of both needleleaf and broadleaf trees.

- o Agriculture/natural vegetation mosaic is the most difficult of the classes because it represents a mixture of human activities and natural vegetation and so there are many examples of where it is misclassified. The most obvious examples are in suburban areas primarily in the eastern United States where there are mosaics of trees, lawns, and artificial surfaces such as asphalt and building materials. Another example of exaggeration is in the Sahel zone of sub-Saharan Africa where there are some small-scale agricultural activities within a savanna or grassland ecosystem, which is already highly seasonal. Other examples include fire scars in boreal zones and recently deforested tropical rainforest.

- The most recent issue discovered is that many training sites have changed between 2000-2009 and these changes have influenced the classification process.

- o The most obvious examples of these changed sites are forest sites occurring in managed forests that have been logged for timber and forest sites that have been devastated by fires. The result is that forest cover in the maps has unnaturally increased between 2002-2009 especially in the mixed, evergreen needleleaf, and deciduous needleleaf forest sites. The problem seems to be worse between 2005-2009 than before 2005. This issue has not been corrected in the data and these changes cannot be considered real changes to land cover.

- o Other unrealistic changes in the maps within the time period include increases of more common classes such as open shrubland and savanna at the expense of grassland and woody savanna.